










**Radio resource allocation method and base station using the same**

**Patent number:** EP1217852  
**Publication date:** 2002-06-26  
**Inventor:** CHEN LAN (JP); UMEDA NARUMI (JP); YAMAO YUSUSHI (JP)  
**Applicant:** NTT DOCOMO INC (JP)  
**Classification:**  
- international: **H04Q7/38; H04Q7/36; H04Q7/38; H04Q7/36; (IPC1-7): H04Q7/36**  
- european: **H04Q7/38C8; H04W36/043**  
**Application number:** EP20010310516 20011217  
**Priority number(s):** JP20000391393 20001222

**Also published as:**

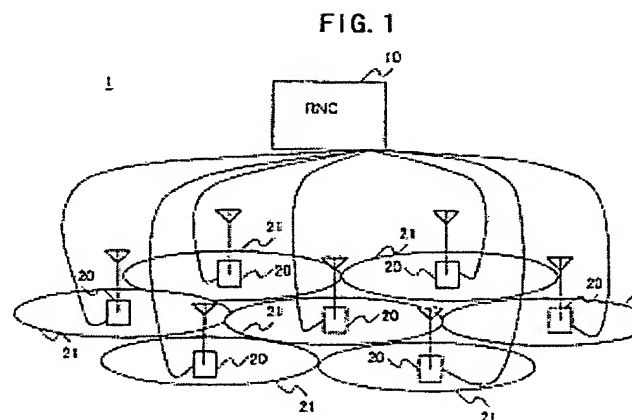
 US2002082021 (A)  
 JP2002199435 (A)  
 EP1217852 (B1)  
 DE60104273T (T2)  
 CN1170446C (C)

**Cited documents:**

 US5867789  
 EP0766416  
 US5724665  
 XP010288215

**Report a data error he****Abstract of EP1217852**

In a radio resource allocation method of the present invention, use-state information of radio resources and priority information of mobile stations using the same radio resources of both a base station of concern and neighboring base stations is detected at the base station of concern. A new radio resource is allocated to a link between the base station of concern and a requesting mobile station in a cell site of the base station of concern based on the use-state information and the priority information of both the base station and the neighboring base stations.



Data supplied from the **esp@cenet** database - Worldwide



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 1 217 852 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
26.06.2002 Bulletin 2002/26

(51) Int Cl.7: **H04Q 7/36**

(21) Application number: **01310516.8**

(22) Date of filing: **17.12.2001**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE TR**  
Designated Extension States:  
**AL LT LV MK RO SI**

(72) Inventors:  
• **Chen, Lan**  
Yokohama-shi, Kanagawa 236-0014 (JP)  
• **Umeda, Narumi**  
Yokohama-shi, Kanagawa 236-0052 (JP)  
• **Yamao, Yusushi**  
Yokosuka-shi, Kanagawa 239-0822 (JP)

(30) Priority: **22.12.2000 JP 2000391393**

(71) Applicant: **NTT DoCoMo, Inc.**  
Tokyo 100-6150 (JP)

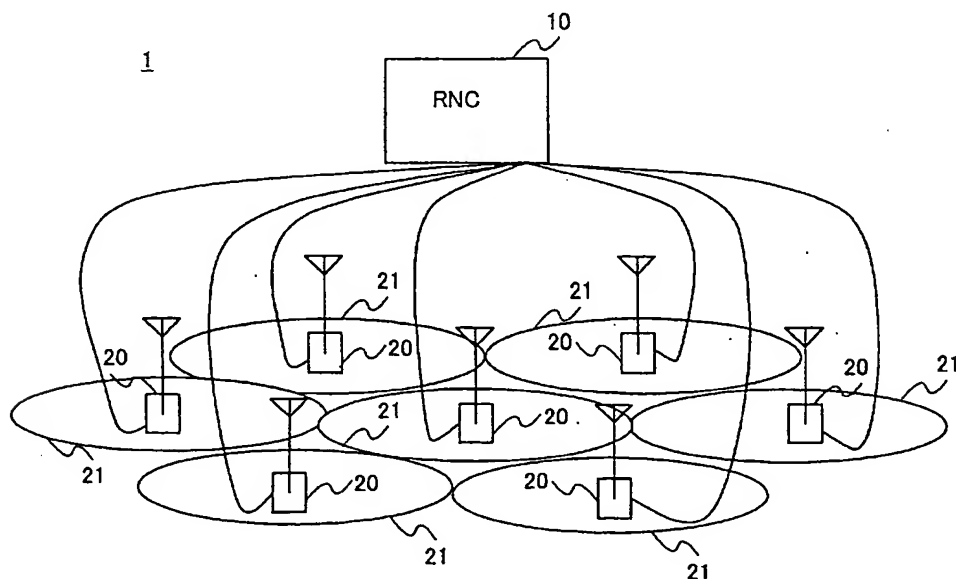
(74) Representative: **Rees, Alexander Ellison et al**  
Urquhart-Dykes & Lord,  
30 Welbeck Street  
London W1G 8ER (GB)

(54) **Radio resource allocation method and base station using the same**

(57) In a radio resource allocation method of the present invention, use-state information of radio resources and priority information of mobile stations using the same radio resources of both a base station of concern and neighboring base stations is detected at the

base station of concern. A new radio resource is allocated to a link between the base station of concern and a requesting mobile station in a cell site of the base station of concern based on the use-state information and the priority information of both the base station and the neighboring base stations.

**FIG. 1**



**EP 1 217 852 A1**

## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of The Invention

[0001] The present invention relates to a radio resource allocation method that controls allocation of up/down link radio resources to mobile stations linked to a base station for use in mobile communications between the mobile stations through the base station. Further, the present invention relates to a base station that uses the radio resource allocation method for mobile communications between mobile stations through the base station.

#### 2. Description of The Related Art

[0002] With the advent of recent multimedia services, mobile communication systems have become to utilize not only the existing voice communications but also non-voice communications including data and image transmissions. In the non-voice communications, the amount of the uplink traffic and the amount of the downlink traffic are often diversified in a non-symmetrical manner. Moreover, the non-voice communications are likely to undergo variations of the amounts of the up/downlink traffic that are larger than those in the voice communications.

[0003] In order to resolve the above problems, it is desirable that radio resources, which must be allocated to mobile stations linked to the base station of concern, be shared for both the uplink and the downlink related to the base station of concern. Radio resources with respect to the present invention mean the radio channels or channel timeslots that have to be allocated to and shared by the respective links between the mobile stations and the base station of concern, namely, both the uplinks between the respective mobile stations and the base station and the downlinks between the base station and the respective mobile stations.

[0004] In a conventional radio resource allocation method, the radio resources are allocated to the uplinks and the downlinks based solely on the comparison of the amount of the uplink traffic and the amount of the downlink traffic in the cell site of the base station of concern. According to the conventional method, when the uplink traffic within the cell site is larger in amount than the downlink traffic there, the base station allocates a larger amount of radio resources to the uplinks than to the downlinks. On the other hand, when the downlink traffic in the cell site of the base station is larger in amount than the uplink traffic there, the base station allocates a larger amount of radio resources to the downlinks than to the uplinks.

[0005] However, according to the above-described conventional method, there is the possibility that the radio resources allocated to the links in the cell site of the

base station of concern are being used in the radio resources allocated to the links in the cell site of a neighboring base station located adjacent to the base station of concern. In such a case, the interference of the radio resources between the base station of concern and the neighboring base station takes place, and the characteristics of the data transmission in both the cell sites of the base stations will deteriorate.

[0006] When the direction of the link data transmission in the cell site of the base station of concern is opposite to the direction of the link data transmission in the cell site of the neighboring base station in the case of allocating the radio resources to both the uplinks and the downlinks, the interference of the radio resources between the base stations or between the mobile stations is likely to take place. Hence, in the case of allocating the radio resources to both the uplinks and the downlinks based solely on the comparison of the uplink and downlink traffic amounts in the cell site of the base station of concern, the interference of the radio resources between the base stations or between the mobile stations is likely to take place, and it will cause the quality of the mobile communications to deteriorate. Further, the interference of the radio resources will cause an increase of the number of retransmissions and an increase of the delay of data transmission, and therefore the efficiency of utilization of the radio resources of the entire mobile communication system will be considerably lowered.

### SUMMARY OF THE INVENTION

[0007] An object of the present invention is to provide an improved radio resource allocation method in which the above-described problems are eliminated.

[0008] Another object of the present invention is to provide a radio resource allocation method that provides efficient use of up/down link radio resources of a base station of concern for use in mobile communications between the mobile stations linked to the base station without causing the interference of the radio resources between the base stations or the mobile stations thereof.

[0009] Another object of the present invention is to provide a base station that uses a radio resource allocation method that provides efficient use of up/down link radio resources of a base station of concern for use in mobile communications between the mobile stations linked to the base station without causing the interference of the radio resources between the base stations or the mobile stations thereof.

[0010] The above-mentioned objects of the present invention are achieved by a method of allocating a new radio resource to a link between a base station and a requesting mobile station in a cell site of the base station, comprising the steps of: detecting use-state information of radio resources and priority information of mobile stations using the same radio resources of both the base station of concern and neighboring base stations;

and allocating a new radio resource to the link between the base station of concern and the requesting mobile station based on the use-state information and the priority information.

[0011] The above-mentioned objects of the present invention are achieved by a base station including a resource allocation control unit which allocates a new radio resource to a link between the base station and a requesting mobile station in a cell site of the base station, the resource allocation control unit comprising: a first unit which detects use-state information of radio resources and priority information of mobile stations using the same radio resources of both the base station of concern and neighboring base stations; and a second unit which allocates a new radio resource to the link between the base station of concern and the requesting mobile station based on the use-state information and the priority information.

[0012] The radio resource allocation method and the base station using the same according to the present invention can prevent the occurrence of the interference of radio resources between the base stations or between the mobile stations. It is possible for the base station of the present invention to provide efficient use of the up/down link radio resources of the base station of concern for use in mobile communications between the mobile stations linked to the base station of concern without causing the interference of the radio resources between the base stations or between the mobile stations.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Other objects, features and advantages of the present invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings.

[0014] FIG. 1 is a diagram of a mobile communication system in which a first preferred embodiment of the radio resource allocation method of the invention is incorporated.

[0015] FIG. 2 is a diagram for explaining a radio resource management table that is used by the radio resource allocation method of the first preferred embodiment.

[0016] FIG. 3 is a block diagram of a base station in which the radio resource allocation method of the first preferred embodiment is incorporated.

[0017] FIG. 4 is a flowchart for explaining a resource allocation control process performed by the base station that uses the radio resource allocation method of the first preferred embodiment.

[0018] FIG. 5 is a diagram of a mobile communication system in which a second preferred embodiment of the radio resource allocation method of the invention is incorporated.

[0019] FIG. 6 is a block diagram of a base station in which the radio resource allocation method of the sec-

ond preferred embodiment is incorporated.

[0020] FIG. 7 is a flowchart for explaining a resource allocation control process performed by the base station that uses the radio resource allocation method of the second preferred embodiment.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] A description will now be provided of preferred embodiments of the present invention with reference to the accompanying drawings.

[0022] FIG. 1 shows a mobile communication system in which a first preferred embodiment of the radio resource allocation method of the invention is incorporated.

[0023] As shown in FIG. 1, the mobile communication system 1 of the present embodiment is formed by a radio network controller 10 (called RNC 10) and a plurality of base stations 20. In the present embodiment, the RNC 10 maintains both the use-state information of a set of radio resources allocated within the cell site 21 of each of the base stations 20 and the priority information related to the mobile stations, which are linked to each base station 20 and use the radio resources allocated thereto.

[0024] In the mobile communication system 1 of the present embodiment, each of the base stations 20 allocates a new radio resource to the link between a requesting mobile station and the base station 20 of concern based on the use-state information of the radio resources in the cell site of each of the base station 20 of concern and its neighboring base stations 20 and the priority information related to the mobile stations using the radio resources allocated thereto, which are both managed by the RNC 10.

[0025] FIG. 2 shows an example of a radio resource management table that is used by the radio resource allocation method of the first preferred embodiment.

[0026] In the present embodiment, the RNC 10 maintains the radio resource management table as shown in FIG. 2, and manages the use-state information of a set of radio resources allocated within the cell site 21 of each of the base stations 20 and the priority information of the mobile stations linked to each base station 20 and using the radio resources allocated thereto.

[0027] In the radio resource management table shown in FIG. 2, each of the base stations 20 is identified by its base station number "BS No.". For example, with respect to the base station #1 (whose base station number is equal to 1), the use-state information of the radio resource management table currently indicates that the radio resource indicated by "RESOURCE-1" is allocated to the uplink between a mobile station and the base station, and the priority information of the radio resource management table currently indicates that a high level of priority is assigned to the mobile station using the radio resource indicated by "RESOURCE-1".

[0028] In the mobile communication system 1 of the present embodiment, when allocating the radio resources to the mobile stations, each of the base stations 20 detects the use-state information of the radio resources in the cell site 21 of the base station 20 of concern and the priority information of the mobile stations using the radio resources allocated thereto by accessing the radio resource management table of the RNC 10. At the same time, the base station 20 of concern sends an inquiry of the radio resource allocation of neighboring base stations 20 (located adjacent to the base station 20 itself) to the RNC 10, and receives, from the radio resource management table of the RNC 10, the use-state information of the radio resources in the cell site 21 of each of the neighboring base stations 20 and the priority information of the mobile stations using the radio resources allocated thereto.

[0029] Accordingly, in the present embodiment, the base station 20 of concern allocates the radio resources to the mobile stations in the cell site 21 thereof based on the use-state information of the radio resources of the base station 20 of concern and the priority information of the mobile stations using the radio resources allocated thereto and based on the use-state information of the radio resources of the neighboring base stations and the priority information of the mobile stations using the radio resources allocated thereto. Therefore, it is possible for the base station of the present embodiment to provide efficient use of the up/down link radio resources of the base station of concern for use in mobile communications between the mobile stations linked to the base station without causing the interference of the radio resources between the base stations or the mobile stations thereof.

[0030] FIG. 3 shows a base station which uses the radio resource allocation method of the first preferred embodiment.

[0031] As shown in FIG. 3, the base station 20 of the present embodiment generally includes a circulator 90, a receiving filter 91, a demodulator unit 92, a decoder unit 93, a resource allocation control unit 95, an up/down frequency control unit 97, a message control unit 98, a transmitting filter 99, a modulator unit 100, a multiplexer unit 101, and an encoder unit 102.

[0032] In the base station 20 of the present embodiment, a signal sent from a mobile station (called the uplink signal) is received at the circulator 90, and it is delivered to the receiving filter 91, the demodulator unit 92 and the decoding unit 93, in this order, so that the unlink data is created at the output of the decoding unit 93 from the received uplink signal.

[0033] Suppose that a request for allocation of a new radio resource to the uplink (or a request for allocation of a new radio resource to the downlink) sent by a requesting mobile station is received at the base station 20. In this case, the received resource allocation request is delivered to the resource allocation control unit 95.

[0034] When the resource allocation request is re-

ceived, the resource allocation control unit 95 analyzes the contents of the request and detects the identification of the requesting mobile station and the link between the requesting mobile station and the base station 20 to which the new radio resource is to be allocated. The resource allocation control unit 95 detects the use-state information of the radio resources within the cell site 21 of the base station 20 of concern and the priority information of the mobile station using the radio resource allocated thereto by accessing the radio resource management table of the RNC 10. At the same time, the resource allocation control unit 95 sends an inquiry of the radio resource allocation of neighboring base stations 20 (located adjacent to the base station 20 of concern) to the RNC 10, and receives, from the radio resource management table of the RNC 10, the use-state information of the radio resources allocated within the cell site 21 of each of the neighboring base stations 20 and the priority information of the mobile stations using the radio resources allocated thereto.

[0035] The identifications (the base station numbers) of the neighboring base stations 20, which are located adjacent to the base station 20 of concern, are predetermined and recorded in the resource allocation control unit 95 at the time of installing the respective base stations 20. The base station 20 of concern maintains such base station numbers of the neighboring base stations 20. As described above, by sending the inquiry of the radio resource allocation of the neighboring base stations 20 to the RNC 10, the resource allocation control unit 95 detects, from the radio resource management table of the RNC 10, the use-state information of the radio resources in the cell site 21 of each of the neighboring base stations 20 and the priority information of the mobile stations using the radio resources allocated thereto.

[0036] Concerning the priority information of the radio resource management table of the present embodiment, a high level of priority is assigned to a mobile station when the real-time processing related to the mobile station, such as the voice transmission, is needed. On the other hand, when the real-time processing related to the mobile station is not needed, a low level of priority is assigned to the mobile station. Alternatively, the priority information of the radio resource management table may be provided such that a high level of priority is assigned to the mobile station when it is contracted to assure high-quality communication of the mobile station, and otherwise a low level of priority is assigned to the mobile station.

[0037] After the use-state information of the radio resources allocated for the neighboring base stations 20 and the priority information of the mobile stations are received, the resource allocation control unit 95 determines the radio resource to be allocated to the requesting mobile station within the cell site 21 of the base station 20 of concern based on the use-state information of the radio resources for the base station 20 of concern

and the priority information of the mobile stations using the radio resources allocated thereto as well as based on the use-state information of the radio resources for each neighboring base station and the priority information of the mobile stations using the radio resources allocated thereto. The control procedure of the resource allocation control unit 95 to determine the radio resource will be described below with reference to FIG. 4.

[0038] The result of the radio resource allocation determined by the resource allocation control unit 95 is supplied to the up/down frequency control unit 97. The up/down frequency control unit 97 produces up/down frequency band control information based on the radio resource allocation result, and outputs the up/down frequency band control information to each of the receiving filter 91 and the transmitting filter 99. The up/down frequency bands for the receiving filter 91 and the transmitting filter 99 are determined by adjustment based on the up/down frequency band control information output by the up/down frequency control unit 97. In the above-described manner, the base station 20 allocates the radio resource to the uplink between the requesting mobile station and the base station 20 of concern, in response to the radio resource allocation request.

[0039] Further, in the base station 20 of FIG. 3, the result of the radio resource allocation determined by the resource allocation control unit 95 is also supplied to the multiplexer unit 101 via the message control unit 98. The multiplexer unit 101 produces a multiplexed signal including the radio resource allocation result supplied from the resource allocation control unit 95 and the downlink data supplied from the encoder unit 102. The multiplexed signal is delivered from the multiplexer unit 101 to the modulator unit 100, the transmitting filter 99 and the circulator 90, in this order, so that it is transmitted from the base station 20 of concern to the requesting mobile station. As the requesting mobile station receives the multiplexed signal from the base station 20, the requesting mobile station recognizes that the radio resource is allocated to the mobile station, based on the resource allocation result included in the multiplexed signal.

[0040] When the radio resource allocation and the radio resource releasing are performed by the base station 20, the resource allocation control unit 95 transmits a radio resource notification to the RNC 10. This radio resource notification contains the updated use-state information of the radio resources in the cell site 21 of the base station 20 of concern and the priority information of the mobile stations using the radio resources allocated thereto. When the radio resource notification from the base station 20 is received, the RNC 10 modifies the radio resource management table based on the received notification so that the radio resource management table is updated.

[0041] FIG. 4 shows a resource allocation control process which is executed by the resource allocation control unit 95 of the base station 20 that uses the radio

resource allocation method of the first preferred embodiment.

[0042] The control process shown in FIG. 4 is started by the resource allocation control unit 95 of the base station 20 in response to a resource allocation request that is sent by a requesting mobile station upon occurrence of a call or a packet data. Hereinafter, the resource allocation control unit 95 is referred to as the control unit 95 for the sake of convenience.

[0043] As shown in FIG. 4, at the start of the resource allocation control process, the control unit 95 detects the use-state information of radio resources in the cell site of the base station 20 of concern and the priority information of the requesting mobile station by accessing the radio resource management table of the RNC 10 (S1).

[0044] After the step S1 is performed, the control unit 95 determines whether there is a non-allocated radio resource in the cell site of the base station 20 of concern (S2). When the result at the step S2 is negative, the control unit 95 places the resource allocation request into a radio resource queue (S11). In this case, after a predetermined period or a randomly set period has elapsed, the control of the control unit 95 is transferred to the step S1 and the control unit 95 repeats performing the subsequent steps.

[0045] When the result at the step S2 is affirmative (a non-allocated radio resource exists), the control unit 95 detects the use-state information of radio resources in the cell sites of the neighboring base stations 20 and the priority information of mobile stations using the radio resources allocated thereto by sending an inquiry to the RNC 10 and accessing the radio resource management table of the RNC 10 (S3).

[0046] After the step S3 is performed, the control unit 95 determines whether the non-allocated radio resource in the cell site of the base station 20 of concern is not in use in the cell sites of the neighboring base stations 20, based on the use-state information related to the neighboring base stations 20 (S4).

[0047] When the result at the step S4 is affirmative, the control unit 95 allocates the radio resource to the link between the requesting mobile station and the base station 20 of concern (S8). After the step S8 is performed, the control unit 95 transmits the radio resource notification to the RNC 10, the notification containing the updated use-state information of the radio resources in the cell site 21 of the base station 20 of concern and the priority information of the mobile stations using the radio resources allocated thereto, so that the radio resource management table of the RNC 10 is updated (S9).

[0048] After the step S9 is performed and the radio resource releasing is performed at the end of the link data transmission, the control unit 95 transmits again the radio resource notification to the RNC 10, the notification containing the updated use-state information of the radio resources in the cell site 21 of the base station 20 of concern and the priority information of the mobile stations using the radio resources allocated thereto, so

that the radio resource management table of the RNC 10 is updated (S10). After the step S10 is performed, the resource allocation control process of FIG. 4 ends.

[0049] When the result at the step S4 is negative (the radio resource is in use), the control unit 95 determines whether the direction of the link data transmission related to the non-allocated radio resource in the cell site of the base station 20 of concern is the same as the direction of the link data transmission related to the allocated radio resource in the cell sites of the neighboring base stations 20 (S5).

[0050] When the result at the step S5 is affirmative (the direction of the link data transmission is the same), the interference of radio resources between the base stations 20 or between the mobile stations is negligible. In this case, the control unit 95 determines whether the allocation of the non-allocated radio resource in the cell site of the base station 20 of concern to the link between the requesting mobile station and the base station 20 of concern is possible (S7). For example, in the step S7, the control unit 95 makes determination as to whether a predetermined SIR (signal-to-interference ratio) is met by the radio resource allocation. When the predetermined SIR is met, it is determined that the resource allocation is possible.

[0051] When the result at the step S7 is affirmative (the resource allocation is possible), the control unit 95 performs the steps S8 to S10 described above. On the other hand, when the result at the step S7 is negative (the resource allocation is not possible), the control unit 95 performs the step S11 described above.

[0052] When the result at the step S5 is negative (the direction of the link data transmission is opposite), the interference of radio resources between the base stations 20 or between the mobile stations is likely to occur. In this case, the control unit 95 determines whether the level of priority of the requesting mobile station in the cell site of the base station 20 of concern is higher than the level of priority of each of the mobile stations using the duplicate radio resource in the cell sites of the neighboring base stations 20, based on the priority information related to the base station 20 of concern and the priority information related to the neighboring base stations 20 (S6).

[0053] When the result at the step S6 is negative (the level of priority of the requesting mobile station is not higher), the control unit 95 performs the step S11 described above. When the result at the step S6 is affirmative (the level of priority of the requesting mobile station is higher), the control unit 95 performs the step S7 described above.

[0054] According to the above-described embodiment, the radio resource allocation method and the base station using the same can prevent the occurrence of the interference of radio resources between the base stations or between the mobile stations by using the radio resource management table of the RNC 10. It is possible for the base station of the above-described embod-

iment to provide efficient use of the up/down link radio resources of the base station of concern for use in mobile communications between the mobile stations linked to the base station of concern without causing the interference of the radio resources between the base stations or between the mobile stations.

[0055] Next, a description will be given of a second preferred embodiment of the radio resource allocation method of the present invention.

[0056] In the previous embodiment, the RNC 10 maintains the use-state information of the radio resources in the cell sites of the respective base stations 20 and the priority information of the mobile stations linked thereto and using the radio resources allocated. In the present embodiment, each of the base stations in the mobile communication system maintains the use-state information of the radio resources in the cell site of the base station of concern and the priority information of the mobile stations linked to the base station of concern and using the radio resources allocated. When allocating a new radio resource, the base station of concern detects the use-state information of the radio resources in the cell sites of the neighboring base stations and the priority information of the mobile stations linked the neighboring base stations by accessing the respective neighboring base stations.

[0057] FIG. 5 shows a mobile communication system in which a second preferred embodiment of the radio resource allocation method of the invention is incorporated.

[0058] As shown in FIG. 5, the mobile communication system 2 of the present embodiment is formed by a radio network controller 30 (called RNC 30) and a plurality of base stations 40. In the present embodiment, when allocating a new radio resource, the base station 40 of concern detects the use-state information of the radio resources in the cell sites of the neighboring base stations 40 and the priority information of the mobile stations linked to the neighboring base stations 40 by accessing the respective neighboring base stations 40. The radio resource allocation is carried out by the base station 40 of concern based on the use-state information of the radio resources in the cell site 41 of each of the base station 40 of concern and the neighboring base stations 40 and the priority information of the mobile stations using the radio resources allocated.

[0059] FIG. 6 shows a base station which uses the radio resource allocation method of the second preferred embodiment.

[0060] As shown in FIG. 6, the base station 40 of the present embodiment generally includes a circulator 190, a receiving filter 191, a demodulator unit 192, a decoder unit 193, a resource allocation control unit 195, an up/down frequency control unit 197, a message control unit 198, a transmitting filter 199, a modulator unit 200, a multiplexer unit 201, and an encoder unit 202.

[0061] In the base station 40 of the present embodiment, a signal sent from a mobile station (the uplink sig-

nal) is received at the circulator 190, and it is delivered to the receiving filter 191, the demodulator unit 192 and the decoding unit 193, in this order, so that the unlink data is created at the output of the decoding unit 193 from the received uplink signal.

[0062] Suppose that a request for allocation of a new radio resource to the uplink sent by a requesting mobile station is received at the base station 40. In this case, the received resource allocation request is delivered to the resource allocation control unit 195.

[0063] When the resource allocation request is received, the resource allocation control unit 195 analyzes the contents of the request and detects the identification of the requesting mobile station and the link between the requesting mobile station and the base station 40 to which the new radio resource is to be allocated. The resource allocation control unit 195 detects the use-state information of the radio resources in the cell site 41 of the base station 40 of concern and the priority information of the mobile station using the radio resource allocated thereto, which are maintained by the base station 40. At the same time, the resource allocation control unit 195 sends an inquiry of the radio resource allocation to neighboring base stations 40 (located adjacent to the base station 40 of concern), and detects, from the neighboring base stations 40, the use-state information of the radio resources in the cell site 41 of each of the neighboring base stations 40 and the priority information of the mobile stations using the radio resources allocated.

[0064] The identifications (the base station numbers) of the neighboring base stations 40, which are located adjacent to the base station 40 of concern, are predetermined and recorded in the resource allocation control unit 195 at the time of installing the respective base stations 40. The base station 40 of concern maintains such base station numbers of the neighboring base stations 40. As described above, by sending the inquiry of the radio resource allocation to the neighboring base stations 40, the resource allocation control unit 195 detects the use-state information of the radio resources in the cell site 41 of each of the neighboring base stations 40 and the priority information of the mobile stations using the radio resources allocated thereto.

[0065] After the use-state information of the radio resources allocated for the neighboring base stations 40 and the priority information of the mobile stations are detected, the resource allocation control unit 195 determines the new radio resource to be allocated to the requesting mobile station in the cell site 41 of the base station 40 of concern based on the use-state information of the radio resources for the base station 40 of concern and the priority information of the mobile stations using the radio resources allocated thereto as well as based on the use-state information of the radio resources for each neighboring base station 40 and the priority information of the mobile stations using the radio resources allocated thereto. The control procedure of the resource allocation control unit 195 to determine the new radio

resource will be described below with reference to FIG. 7.

[0066] The operations of the resource allocation control unit 195 after the determination of the new radio resource are essentially the same as those of the previous embodiment of FIG. 3, and a description thereof will be omitted.

[0067] Further, in the present embodiment, when an inquiry of the radio resource allocation from a neighboring base station 40 is received at the base station 40 of concern, the resource allocation control unit 195 transmits to the neighboring base station 40 the use-state information of the radio resources in the cell site 41 of the base station 40 of concern and the priority information of the mobile station using the radio resource allocated thereto.

[0068] Further, in the present embodiment, when transmitting the inquiry, the use-state information or the priority information from the base station 40 of concern to the neighboring base station 40 or vice versa, a wired or wireless dedicated radio channel is used as a path of the data transmission.

[0069] FIG. 7 shows a resource allocation control process performed by the resource allocation control unit 195 of the base station 40 that uses the radio resource allocation method of the second preferred embodiment.

[0070] The control process shown in FIG. 7 is started by the resource allocation control unit 195 of the base station 40 in response to a resource allocation request that is sent by a requesting mobile station upon occurrence of a call or a packet data. Hereinafter, the resource allocation control unit 195 is referred to as the control unit 195 for the sake of convenience.

[0071] As shown in FIG. 7, at the start of the resource allocation control process, the control unit 195 detects the use-state information of radio resources in the cell site of the base station 40 of concern and the priority information of the requesting mobile station which are both maintained by the base station 40 of concern (S21).

[0072] After the step S21 is performed, the control unit determines whether there is a non-allocated radio resource in the cell site 41 of the base station 40 of concern (S22). When the result at the step S22 is negative, the control unit 195 places the resource allocation request into a radio resource queue (S29). In this case, after a predetermined period or a randomly set period has elapsed, the control of the control unit 195 is transferred to the step S21 and the control unit 195 repeats performing the subsequent steps.

[0073] When the result at the step S22 is affirmative (a non-allocated radio resource exists), the control unit 195 detects the use-state information of radio resources in the cell sites of the neighboring base stations 40 and the priority information of mobile stations using the radio resources allocated thereto by sending an inquiry to the neighboring base stations 40 and accessing the radio resource allocation information thereof (S23).



[0074] After the step S23 is performed, the control unit 195 determines whether the non-allocated radio resource in the cell site of the base station 40 of concern is not in use in the cell sites of the neighboring base stations 40, based on the use-state information related to the neighboring base stations 40 (S24).

[0075] When the result at the step S24 is affirmative, the control unit 195 allocates the radio resource to the link between the requesting mobile station and the base station 40 of concern (S28). After the step S8 is performed, the resource allocation control process of FIG. 7 ends.

[0076] When the result at the step S24 is negative (the radio resource is in use), the control unit 195 determines whether the direction of the link data transmission related to the non-allocated radio resource in the cell site of the base station 40 of concern is the same as the direction of the link data transmission related to the allocated radio resource in the cell sites of the neighboring base stations 40 (S25).

[0077] When the result at the step S25 is affirmative (the direction of the link data transmission is the same), the interference of radio resources between the base stations 40 or between the mobile stations is negligible. In this case, the control unit 195 determines whether the allocation of the non-allocated radio resource in the cell site of the base station 40 of concern to the link between the requesting mobile station and the base station 40 of concern is possible (S27). For example, in the step S27, the control unit 195 makes determination as to whether a predetermined SIR (signal-to-interference ratio) is met by the radio resource allocation. When the predetermined SIR is met, it is determined that the resource allocation is possible.

[0078] When the result at the step S27 is affirmative (the resource allocation is possible), the control unit 195 performs the step S28 described above. On the other hand, when the result at the step S27 is negative (the resource allocation is not possible), the control unit 195 performs the step S29 described above.

[0079] When the result at the step S25 is negative (the direction of the link data transmission is opposite), the interference of radio resources between the base stations 40 or between the mobile stations is likely to occur. In this case, the control unit 195 determines whether the level of priority of the requesting mobile station in the cell site of the base station 40 of concern is higher than the level of priority of each of the mobile stations using the duplicate radio resource in the cell sites of the neighboring base stations 40, based on the priority information related to the base station 40 of concern and the priority information related to the neighboring base stations 40 (S26).

[0080] When the result at the step S26 is negative (the level of priority of the requesting mobile station is not higher), the control unit 195 performs the step S29 described above. When the result at the step S26 is affirmative (the level of priority of the requesting mobile station

is higher), the control unit 195 performs the step S27 described above.

[0081] According to the above-described embodiment, the radio resource allocation method and the base station using the same can prevent the occurrence of the interference of radio resources between the base stations or between the mobile stations by using the radio resource allocation information maintained by the individual base stations 40. It is possible for the base station of the above-described embodiment to provide efficient use of the up/down link radio resources of the base station of concern for use in mobile communications between the mobile stations linked to the base station of concern without causing the interference of the radio resources between the base stations or between the mobile stations.

[0082] In the above embodiments of FIG. 1 and FIG. 5, the cell of each base station is not divided. However, the present invention is not limited to these embodiments. The radio resource allocation method of the present invention is applicable to the case in which the cell of each base station is divided into a plurality of sectors. In such alternative embodiment, the base station may be configured to detect the use-state information of radio resources related to each of the respective sectors of the cell of concern and the priority information of mobile stations using the radio resources allocated.

[0083] The present invention is not limited to the above-described embodiments, and variations and modifications may be made without departing from the scope of the present invention.

[0084] Further, the present invention is based on Japanese priority application No. 2000-391393, filed on December 22, 2000, the entire contents of which are hereby incorporated by reference.

## Claims

1. A method of allocating a new radio resource to a link between a base station and a requesting mobile station in a cell site of the base station, comprising the steps of:
  - detecting use-state information of radio resources and priority information of mobile stations using the same radio resource of both the base station of concern and neighboring base stations; and
  - allocating a new radio resource to the link between the base station of concern and the requesting mobile station based on the use-state information and the priority information.
2. A method of allocating a new radio resource to a link between a base station and a requesting mobile station in a cell site of the base station, comprising the steps of:

- detecting use-state information of radio resources and priority information of mobile stations using the same radio resource of both the base station of concern and neighboring base stations;  
determining whether a direction of link data transmission related to the non-allocated radio resource is the same as a direction of link data transmission related to an allocated radio resource in one of the cell sites of the neighboring base stations; and  
allocating a new radio resource to the link between the base station of concern and the requesting mobile station based on both the use-state information and the priority information in said detecting step and a result of the determination in said determining step.
3. The method according to claim 1, further comprising the steps of:
- determining whether there is a non-allocated radio resource in the cell site of the base station of concern;  
determining whether the non-allocated radio resource is not in use in the respective cell sites of the neighboring base stations;  
determining whether a direction of a link data transmission related to the non-allocated radio resource is the same as a direction of a link data transmission related to an allocated radio resource in one of the cell sites of the neighboring base stations;  
determining whether a level of priority of the requesting mobile station is higher than a level of priority of each of the mobile stations using the radio resources allocated; and  
determining whether allocation of the non-allocated radio resource in the cell site of the base station of concern to the link is possible.
4. The method according to claim 2, wherein a radio network controller maintains a radio resource management table, and, in said detecting step, the base station of concern detects the use-state information and the priority information from the radio resource management table of the radio network controller by sending an inquiry from the base station of concern to the radio network controller.
5. The method according to claim 2, wherein a radio network controller maintains a radio resource management table, and, when the radio resource allocation and radio resource releasing are performed, the base station of concern transmits a radio resource notification to the radio network controller so that the radio resource management table is updated.
6. The method according to claim 2, wherein each of the base station of concern and the neighboring base stations maintains the use-state information of that base station and the priority information of the mobile stations related to that base station, and, in said detecting step, the base station of concern detects the use-state information and the priority information from the respective neighboring base stations by sending an inquiry from the base station of concern to each of the respective neighboring base stations.
7. The method according to claim 6, wherein, when transmitting the inquiry, the use-state information or the priority information between the base station of concern and each of the neighboring base stations, a dedicated radio channel is used as a path of the data transmission.
8. The method according to claim 2, wherein each of the base station of concern and the neighboring base stations maintains the use-state information of that base station and the priority information of the mobile stations related to that base station, and, when an inquiry from one of the neighboring base stations is received at the base station of concern, the base station of concern transmits to said one of the neighboring base stations the use-state information and the priority information both related to the base station of concern.
9. The method according to claim 8, wherein, when transmitting the use-state information or the priority information between the base station of concern and said one of the neighboring base stations, a dedicated radio channel is used as a path of the data transmission.
10. The method according to claim 2, wherein respective identifications of the neighboring base stations are predetermined and recorded, in advance, in the base station of concern.
11. A base station including a resource allocation control unit which allocates a new radio resource to a link between the base station and a requesting mobile station in a cell site of the base station, the resource allocation control unit comprising:
- a first unit detecting use-state information of radio resources and priority information of mobile stations using the same radio resources of both the base station of concern and neighboring base stations; and  
a second unit allocating a new radio resource to the link between the base station of concern and the requesting mobile station based on the use-state information and the priority information.

tion.

12. The base station according to claim 11, further comprising a determining unit determining whether a direction of link data transmission related to the non-allocated radio resource is the same as a direction of link data transmission related to an allocated radio resource in one of the cell sites of the neighboring base stations, wherein said second unit allocates the new radio resource to the link based on both the use-state information and the priority information detected by the first unit and a result of the determination provided by the determining unit.

13. The base station according to claim 11, further comprising:

a third unit determining whether there is a non-allocated radio resource in the cell site of the base station of concern;  
a fourth unit determining whether the non-allocated radio resource is not in use in the respective cell sites of the neighboring base stations;  
a fifth unit determining whether a direction of a link data transmission related to the non-allocated radio resource is the same as a direction of a link data transmission related to an allocated radio resource in one of the cell sites of the neighboring base stations;  
a sixth unit determining whether a level of priority of the requesting mobile station is higher than a level of priority of each of the mobile stations using the radio resources allocated; and  
a seventh unit determining whether allocation of the non-allocated radio resource in the cell site of the base station of concern to the link is possible.

14. The base station according to claim 12, wherein a radio network controller maintains a radio resource management table, and, said first unit detects the use-state information and the priority information from the radio resource management table of the radio network controller by sending an inquiry from the base station of concern to the radio network controller.

15. The base station according to claim 12, wherein a radio network controller maintains a radio resource management table, and, when the radio resource allocation and radio resource releasing are performed, the resource allocation control unit transmits a radio resource notification to the radio network controller so that the radio resource management table is updated.

16. The base station according to claim 12, wherein each of the base station of concern and the neigh-

boring base stations maintains the use-state information of that base station and the priority information of the mobile stations related to that base station, and said first unit detects the use-state information and the priority information from the respective neighboring base stations by sending an inquiry from the base station of concern to each of the respective neighboring base stations.

17. The base station according to claim 16, wherein, when transmitting the inquiry, the use-state information or the priority information between the base station of concern and each of the neighboring base stations, a dedicated radio channel is used as a path of the data transmission.

18. The base station according to claim 12, wherein each of the base station of concern and the neighboring base stations maintains the use-state information of that base station and the priority information of the mobile stations related to that base station, and, when an inquiry from one of the neighboring base stations is received at the base station of concern, the base station of concern transmits to said one of the neighboring base stations the use-state information and the priority information both related to the base station of concern.

19. The base station according to claim 18, wherein, when transmitting the use-state information or the priority information between the base station of concern and said one of the neighboring base stations, a dedicated radio channel is used as a path of the data transmission.

20. The base station according to claim 12, wherein respective identifications of the neighboring base stations are predetermined and recorded, in advance, in the base station of concern.

FIG. 1

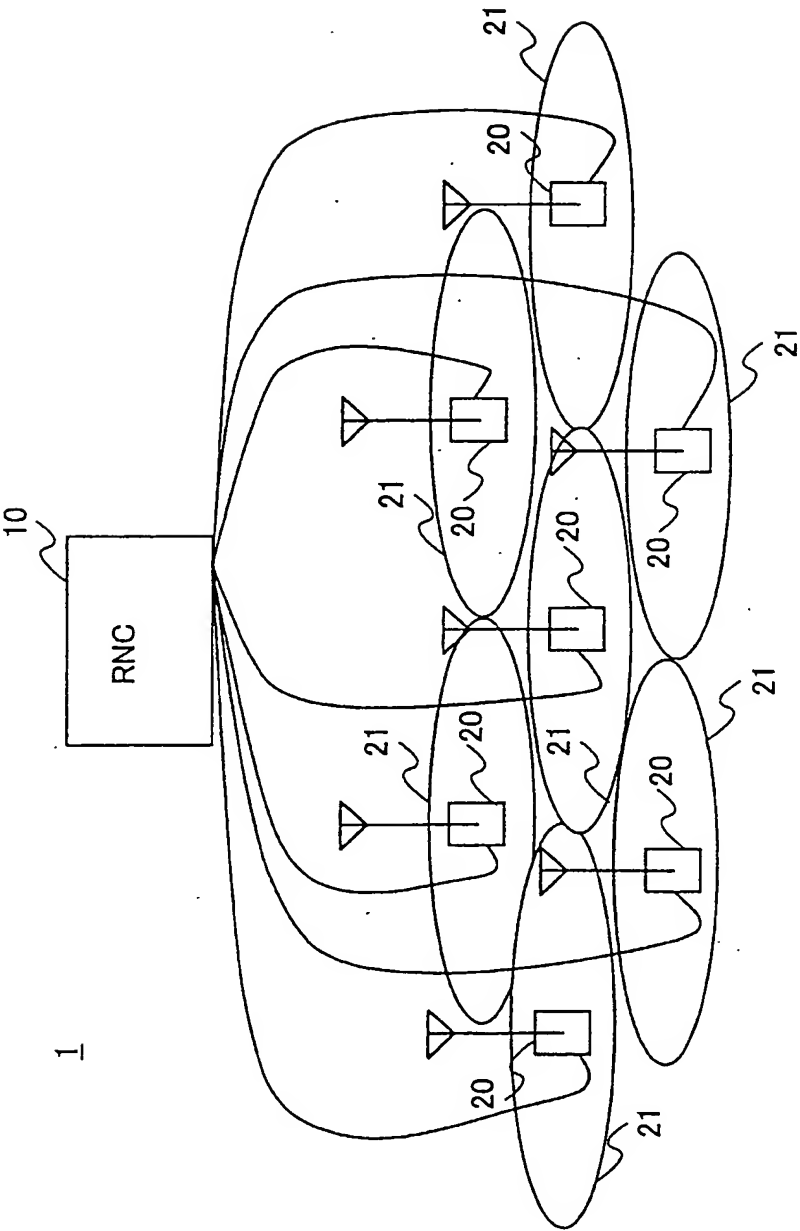


FIG.2

BS NO.	RESOURCE-1		RESOURCE-2		....	RESOURCE-N	
1	UP LINK IN USE	PRIORITY HIGH	NOT IN USE	-	... ...	DN LINK IN USE	PRIORITY LOW
2	NOT IN USE	-	NOT IN USE	-	... ...	NOT IN USE	-
3	DN LINK IN USE	PRIORITY HIGH	DN LINK IN USE	PRIORITY HIGH	... ...	NOT IN USE	-
....	...	...	...	...	...	....	....
M	DN LINK IN USE	PRIORITY HIGH	NOT IN USE	-		UP LINK IN USE	PRIORITY HIGH

FIG.3

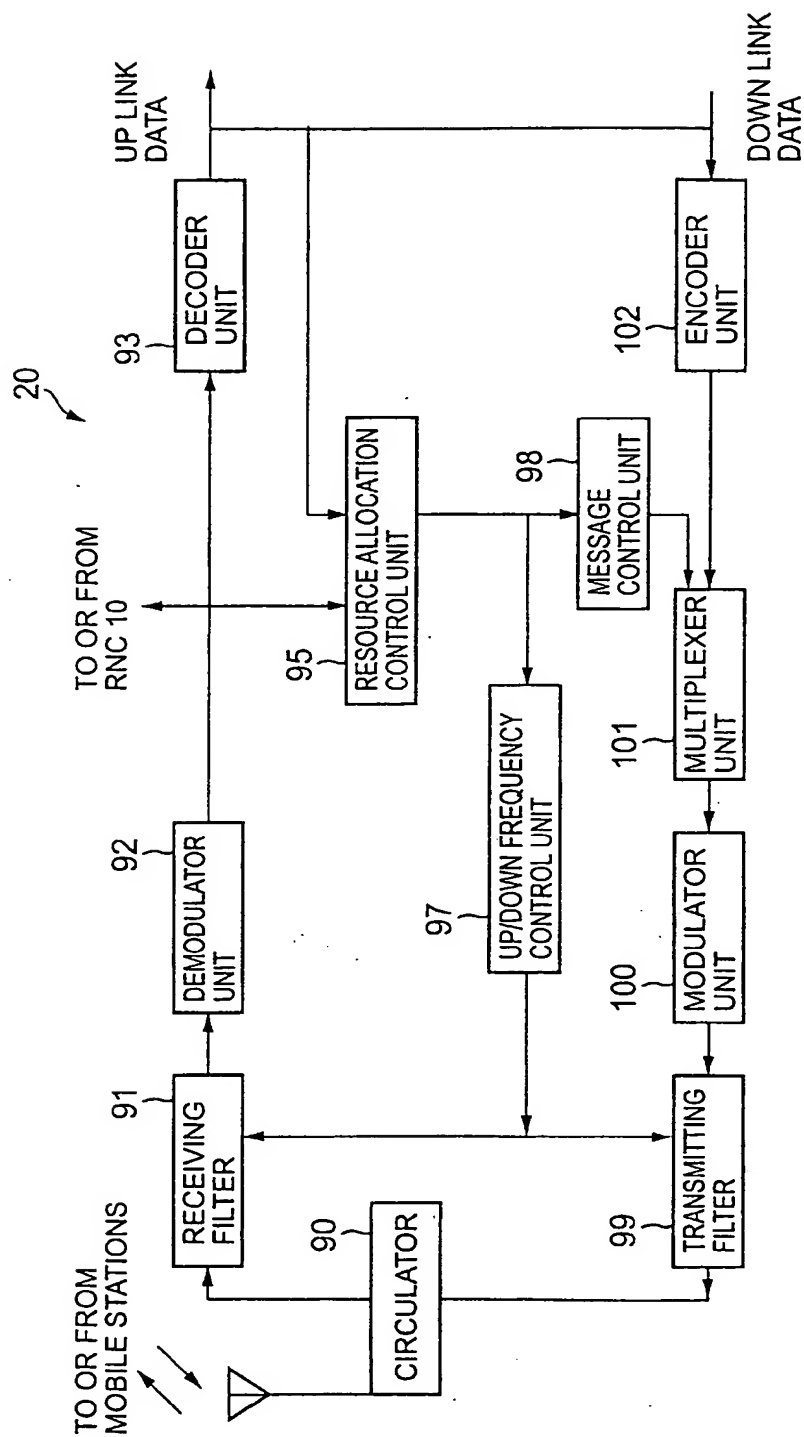


FIG.4

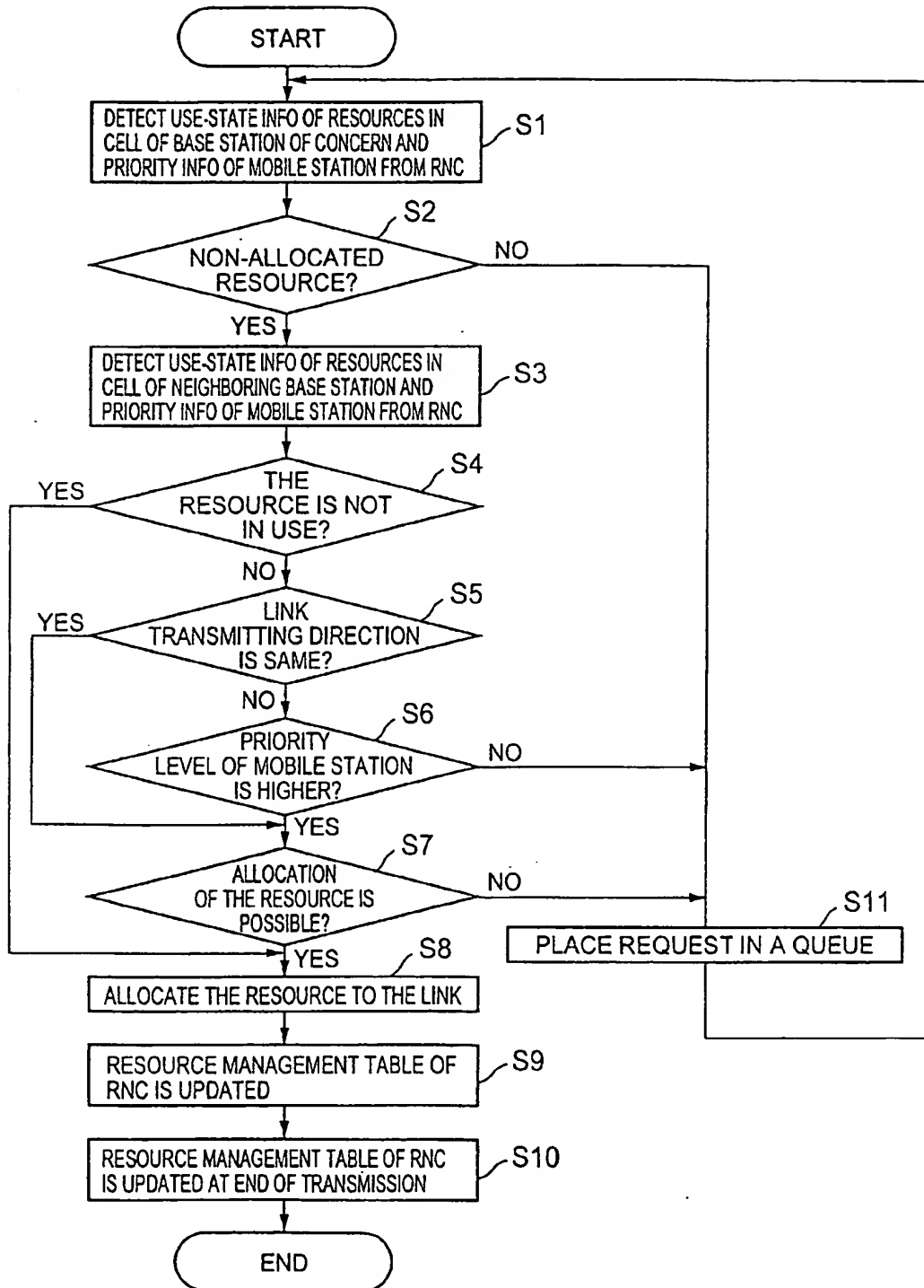


FIG. 5

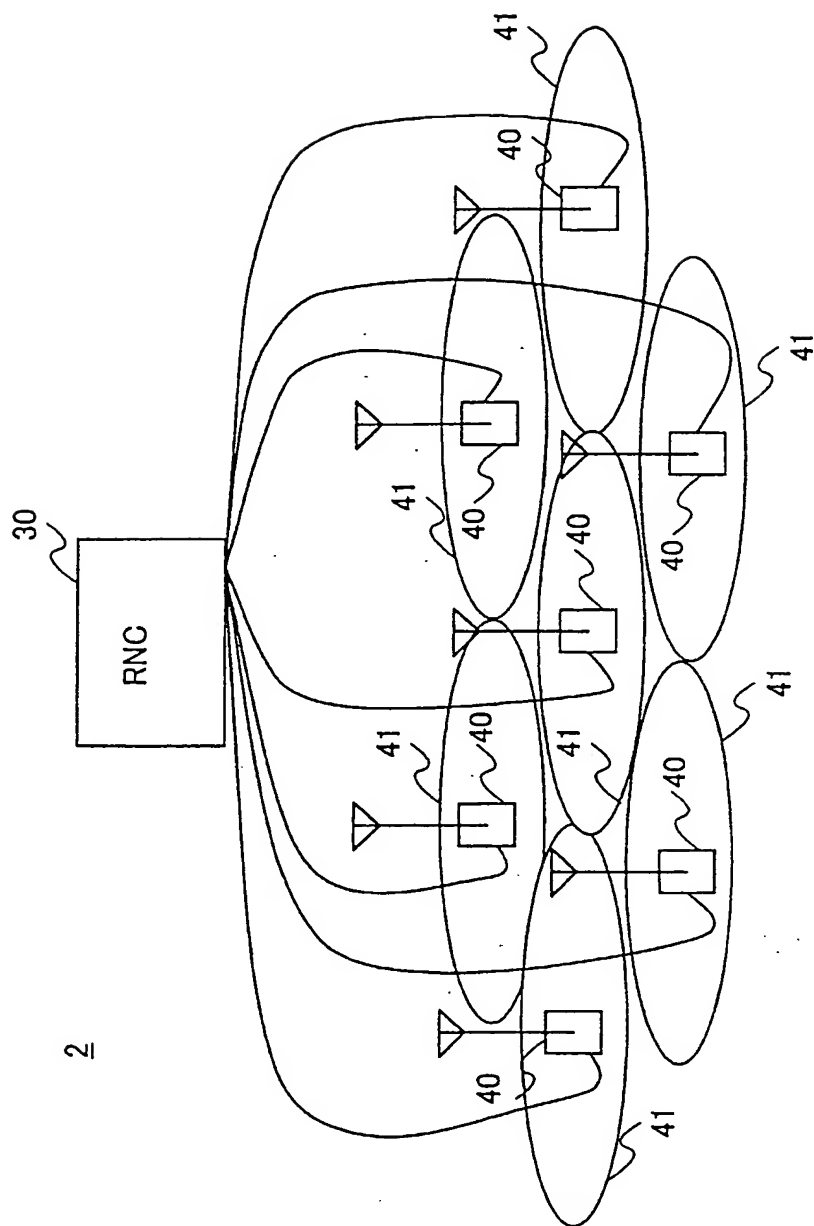




FIG.6

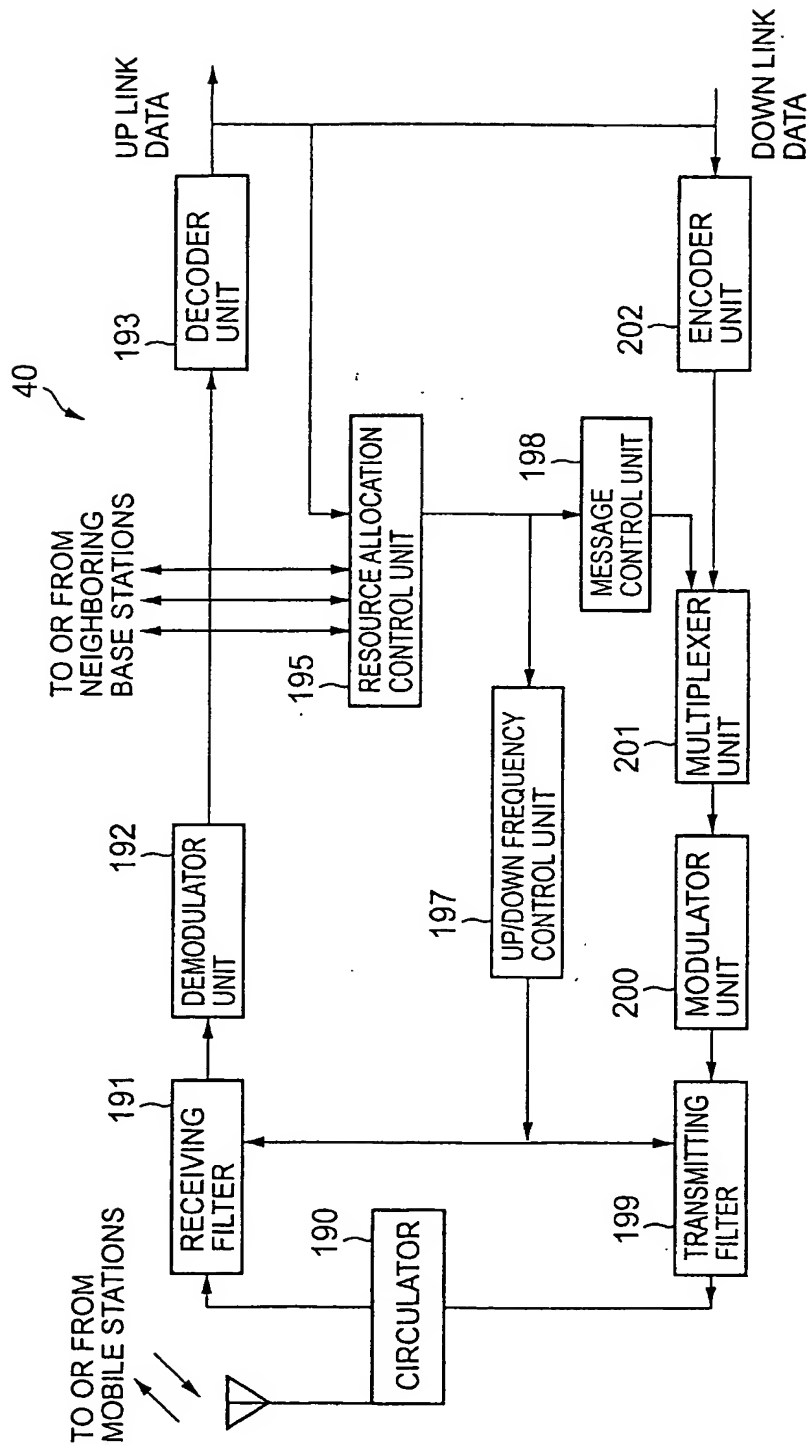
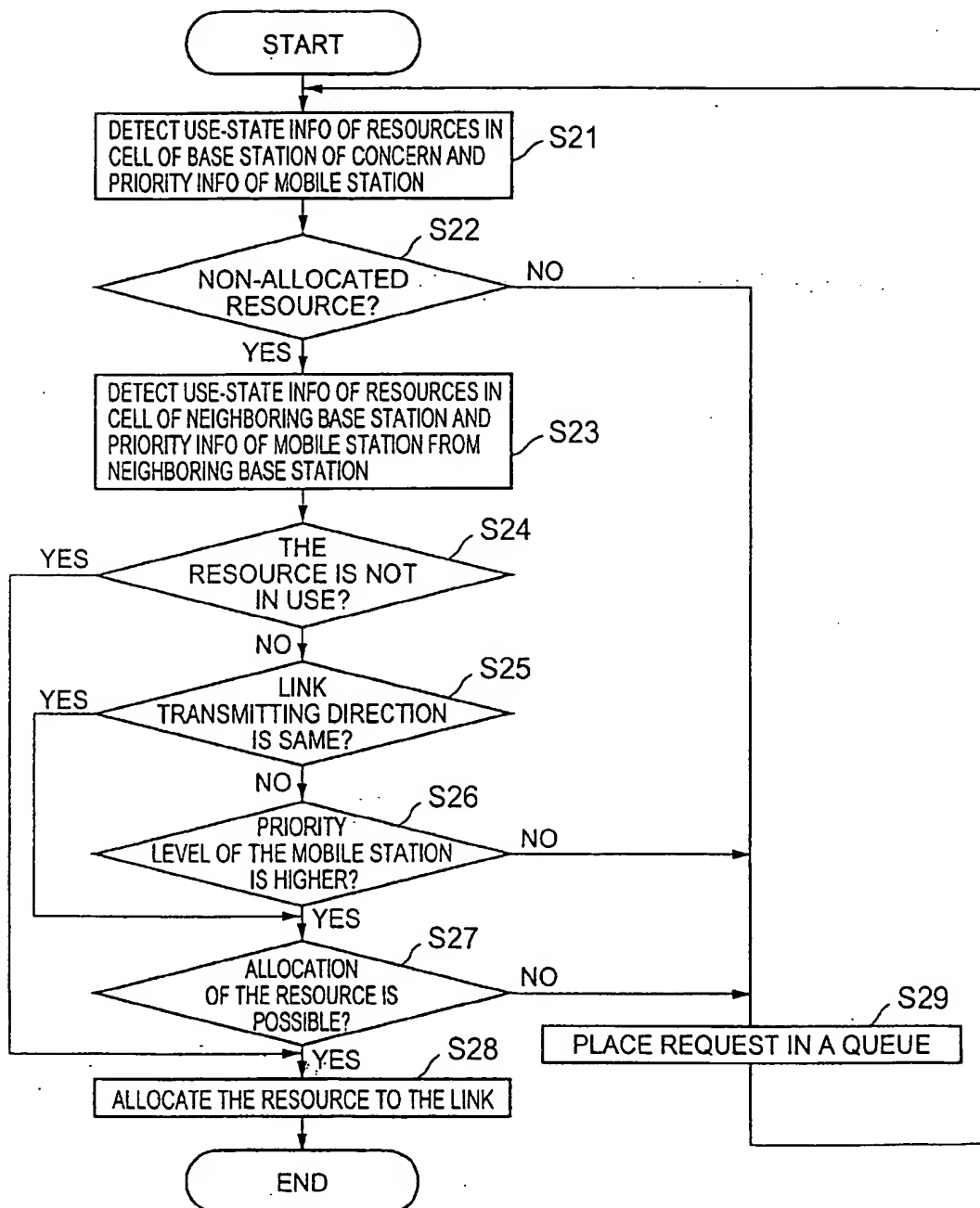


FIG.7





European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 01 31 0516

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 867 789 A (DAVIEAU GERALD JOSEPH ET AL) 2 February 1999 (1999-02-02)	1,11	H04Q7/36
Y	* the whole document *	2-10, 12-20	
Y	--- EP 0 766 416 A (AT & T CORP) 2 April 1997 (1997-04-02) * the whole document *	2-10, 12-20	
A	--- MIHAILESCU C ET AL: "Dynamic resource allocation in locally centralized cellular systems" VEHICULAR TECHNOLOGY CONFERENCE, 1998. VTC 98. 48TH IEEE OTTAWA, ONT., CANADA 18-21 MAY 1998, NEW YORK, NY, USA, IEEE, US, 18 May 1998 (1998-05-18), pages 1695-1699, XP010288215 ISBN: 0-7803-4320-4 * the whole document *	4,5,14, 15	
A	--- US 5 724 665 A (GVOTH THOMAS GERARD ET AL) 3 March 1998 (1998-03-03) * abstract *	7,9,17, 19	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04Q
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 12 April 2002	Examiner Quaranta, L
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.82 (904C01)

BEST AVAILABLE COPY

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 31 0516

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

12-04-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5867789 A	02-02-1999	DE 19751869 A1	02-07-1998
		FR 2758041 A1	03-07-1998
		GB 2320856 A	01-07-1998
EP 0766416 A	02-04-1997	US 5768254 A	16-06-1998
		CA 2181398 A1	30-03-1997
		EP 0766416 A2	02-04-1997
		JP 3066326 B2	17-07-2000
		JP 9130326 A	16-05-1997
US 5724665 A	03-03-1998	NONE	

EPO FORM P459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**BEST AVAILABLE COPY**